

ASTR 350 Introduction to Astrophysics: Stars

Course Syllabus Fall 2018

Instructor: Dr. Patrick Hartigan, Hermann Brown 350, Phone: X2245

Time: TTh 10:50 am - 12:05 pm; Makeup classes held Friday 3:00 pm - 4:15 pm as needed

Room: HBH 254

Office Hours: After class on T and Th, and by appt.

Outline of Course:

ASTR 350 (Introduction to Astrophysics: Stars) and ASTR 360 (Galaxies and Cosmology) provide a year-long introduction to the branch of physics that deals with celestial objects. The courses may be taken in either order. Both are required for the BS degree in Astrophysics and the BA in Astronomy. Nearly all majors take ASTR 350 as juniors; however, it is not uncommon to have sophomores in the ASTR 360 class. Occasionally majors outside of physics will either audit or take these classes for credit. The graduate level version of these courses is 451 and 452. ASTR 350 and ASTR 360 prepare our majors for these graduate courses, which are standard at schools throughout the country.

In ASTR 350, we begin by following the calculations of Kepler and Newton to derive the equations that describe the motions of celestial objects under the influence of gravity, and will apply these equations to various phenomena of interest in astronomy such as binary stars, cometary orbits, tides, and planetary rings. After some discussion of observational astronomy and modern physics we will be able to determine how stars (including the Sun) are born, why they shine, what happens as they age, and how they die. We then consider the bizarre world of compact objects, where gravity bends light and time is slowed. At the end of the course we will touch upon the subject of stellar atmospheres, something covered in detail in ASTR 451.

Much of the physics and mathematics needed to study astrophysics is first learned as juniors and seniors, so complete mathematical rigor is not possible. However, I will strive to present as clear and complete a picture as possible given the time constraints of the course. More rigorous derivations will appear in ASTR 451 and ASTR 452.

Text:

Carroll and Ostlie *Introduction to Astrophysics* (1999) -- A thorough undergraduate text with excellent introductory sections on stellar evolution and stellar atmospheres. This text is also used in part for ASTR 360 Galaxies and Cosmology.

Supplementary Texts:

Shu *The Physical Universe* (1982) -- Contains an interesting discussion of fusion from the standpoint of particle physics, and a brief discussion of stellar interiors.

Zeilik and Gregory *Introductory Astronomy and Astrophysics* (1998) -- A brief introduction to the field with an emphasis on observations.

Bohm-Vitense *Stellar Astrophysics v1: Basic Stellar Observations and Data* (1989)

Bohm-Vitense *Stellar Astrophysics v2: Stellar Atmospheres* (1989)

Bohm-Vitense *Stellar Astrophysics v3: Stellar Structure* (1989) -- Short texts on the subjects with an emphasis on observations, and written at a somewhat lower level than the graduate texts.

Internet Disturbances:

Please turn off all ringing, beeping devices and do not surf the internet, text, tweet, update Facebook, take selfies, email, chat, or use any other electronic diversion during class. If you must do anything like that, take it outside.

Grading:

Grades will be based on homework problems (20%), an exam October 2 (15%), a second exam November 20 (15%), a final project presented to the class (20%) sometime in December, and a final comprehensive exam (30%). As part of your final project you will create your own HTML document for distribution on the web. Exams are closed book, closed notes, one-hour oral examinations conducted in my office. Here is the [grade distribution](#) from the six previous times I have taught the course.

Absence and Late Policies:

There are no specific requirements regarding class attendance on lecture days. However, I don't think I've ever seen a student do well in this class without regular attendance. The material is complex and difficult to learn from a book. Students must attend on presentation days and must be on time for all oral exams. There are no makeups for these except for doctor-verified illnesses. If students know beforehand they will not be available for presentations or exams they should contact me ASAP so hopefully we may reschedule for the entire class. Homeworks must be turned in on time to receive full credit.

Honor Code:

A [general description of the honor code](#) is available on-line.

EXAMS: Once students have taken an oral exam they cannot discuss the contents of the exam until all students in the class have taken the test.

PROBLEMS: Problems are an important component to this class, and I will assign them in problem sets, probably 3 or 4 such sets throughout the semester. We may not have time to cover all the solutions in class, so if necessary we may meet at some other time to discuss problems. The honor code applies to the problems in the following way. If the student cannot solve a problem in an hour, the student can keep working on it alone or ask for hints from a classmate who has done the problem. After writing up the problem, students should describe the level of help they required in doing it. Students should turn in their own work and analysis on the homework sets, but may discuss the general nature of the problems with one-another.

Auditors:

Should attend class, but can do problems and presentations and exams or not as they wish.

COURSE ACTIVITIES

Lectures:

We will cover the material on the schedule as described below. It will be helpful if students attempt to read the material before we cover it in class. We will use the contents of the book as a guide, but lectures will have their own derivations and at times a different emphasis and may involve related material.

Presentations:

For the project, students will pick some topic of current interest that relates to the material covered in class. Students will work with the instructor to define these topics. Projects may be purely based on reading, or may involve some calculation and coding. The presentations should be about 25 minutes long (depending on class size), and are *informal*. There is no need to make a fancy powerpoint presentation like you might do for a seminar talk. However, it is important for students to understand all the basic physics as it relates to what you are doing. Students should introduce the subject clearly and identify what they have done. This is one way for students to get some practice teaching. [Examples of previous projects](#) are available.

Exams:

I conduct individual one hour oral exams in my office, twice during the semester and once as a final. Exams cover basic material we studied in class. Although sometimes painful, all students need to learn how to handle oral exam situations without panicking or freezing up, because that is how qualifying exams are done, and, eventually, what job interviews are like. There really is no better way to find out what someone knows than to see what they write on the board. We have three of them to allow people to get used to doing them, with the final weighted the most. Material on the exams is pledged in the sense that no one may discuss the contents of the exams or provide any hints as to what to study until all class members have taken it. At the risk of stating the obvious, no aids of any kind are allowed during the oral exams, and they cannot be taped.

COURSE SCHEDULE

The following is a target schedule for the semester. At present there is no need for makeup days, but that can change as various external events intervene. If we do need to reschedule a class for some reason we will hold them at 3pm on Friday, assuming that works for the majority of students. The official schedule, as well as any policy changes, will be posted on the [course website](#). If you are reading this document from the Rice course pages, recognize that it sets the initial schedule, but may be modified as the semester proceeds.

TOPIC	CHAPTER	NUMBER OF LECTURES	DATES
Celestial Mechanics	1,2,7	4	T 8/21, Th 8/23, T 8/28, Th 8/30
Planetary Rings and Tides	20,21	2	T 9/4, Th 9/6
Asteroids	22	1	T 9/11
Photometric Concepts	3	2	Th 9/13, T 9/18
Radiation and Temperature	5,9	3	Th 9/20, T 9/25, Th 9/27
-----		EXAM #1	T 10/2
Stellar Spectra	8	1	Th 10/4
---	Midterm break: NO CLASS	---	T 10/9
Stellar Structure	10	3	Th 10/11, T 10/16, Th 10/18
The Sun	11	1	T 10/23
Stellar Evolution	12,13	3	Th 10/25, 10/30, 11/1
Supernovae, Variable Stars	14,15	1	11/6
Compact Stellar Remnants	16,17,18	3	11/8, 11/13, 11/15
-----		EXAM #2	T 11/20
---	Thanksgiving: NO CLASS	---	Th 11/22
Stellar Atmosphere Models	8,9	2	T 11/27, Th 11/29
-----		Final Exams	T 12/6
-----		Final Projects	W 12/12

Outcomes/Assessments

(This section is now required by the Rice Administration for all Syllabi)

Goals for students in this class include:

- Combine concepts from various branches of physics, including thermodynamics, mechanics, quantum mechanics, and optics, with mathematical tools to explain the formation, interaction, and evolution of astronomical bodies
- Understand how the equations of gravity give rise to orbital motion
- Understand the basics of light, including continuum emission and absorption lines, and be able to identify how these processes relate to stellar spectra
- Learn about fusion, and be able to explain how the equations of stellar structure arise and how they govern stellar evolution
- Acquire a basic understanding of equations of state and learn how they influence the properties of compact objects such as white dwarfs, neutron stars and black holes
- Learn how the Sun and solar system formed, why it evolved to its present state, and be able to explain its ultimate fate
- Gain experience in taking oral examinations by reasoning and explaining complex concepts face-to-face under time pressure
- Assess research talks and proposals that rely upon knowledge of stellar evolution by drawing upon basic concepts learned in class
- Improve speaking and presentation skills during oral presentations

Disabled Students:

Students with a documented disability that impacts their work in this class should contact me to discuss their needs. Disabled students should also register with the Disability Support Services Office in the Ley Student Center.